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Beckman Scholars Program

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BECKMAN SCHOLARS PROGRAM

The Beckman Scholars Program, established in 1997, is an invited program for accredited universities and four-year colleges in the US. It provides scholarships that contribute significantly to advancing the education, research training, and personal development of select students in chemistry, biochemistry, and the biological and medical sciences. The sustained, in-depth undergraduate research experiences and comprehensive faculty mentoring are unique in terms of program scope, content, and level of scholarship awards. The University of Kentucky has been invited to apply for the program three times, and was selected to participate for three years beginning in 2002, and for a second three years beginning in 2005.

The Beckman Scholars Program provides support for no more than three outstanding undergraduate researchers per year. Scholars receive support for two summers and the intervening academic year, including a generous scholarship award plus stipends for supplies and travel. Scholars must conduct their research in chemistry, biochemistry, the biological and medical sciences, or some interdisciplinary combination of these disciplines, in the laboratory of and under the mentorship of a University of Kentucky faculty member approved by the Beckman Foundation.

Being named a Beckman Scholar is an extraordinarily high honor. The process by which a scholar is selected is quite rigorous. The selection is conducted by a committee of research faculty members each with a strong record of mentoring undergraduate researchers. The selection process evaluates 1) the ability of the candidate in both written and oral communication by considering a required research essay and conducting an interview of each finalist; 2) the past achievements of the candidate by reviewing the entire undergraduate transcript, academic honors received, and all previous research experience; 3) the candidate's intellect, character, and potential to excel as a researcher by appraising

a required written research plan and at least three letters of support from current and prospective faculty mentors; and 4) the candidate's potential for a career in research by evaluating a required written statement of educational and career plans.

To apply to become a Beckman Scholar, a student must be a sophomore or junior at the University of Kentucky, majoring in Chemistry, Biology, or a closely related discipline (such as chemical engineering or agricultural biotechnology), and have already completed at least one semester of research experience.

The Beckman Scholars for the year 2005-2006 were Nicolas Badre (mentored by Professor Robin Cooper) and Jason Passafiume (mentored by Professor Bruce O'Hara). The Beckman Scholars named for the year 2006-2007 are Megan Culler (mentored by Professors Rebecca Dutch and Diane Snow) and Kathryn Schweri (mentored by Professor Chris Schardl). In the following articles, the 2005-2006 Scholars explain and discuss their research.

For more information on the Beckman Scholars Program at the University of Kentucky, visit www.uky.edu/beckman.



Nicholas Badre



Jason Passafiume





Selection Process

At the beginning of my sophomore year, I had finished writing about my research for my first principal-authored publication. At that time, Dr. Cooper informed me of the possibility of applying as a Beckman Scholar. The selection process mainly consisted of an extensive project proposal, a personal statement, a résumé, and letters of recommendation. The application having separated me enough from other candidates, I was not required to go through the interview process given to most candidates. The Beckman selection committee at the University already knew me from courses and personal interaction, so maybe I was really being interviewed throughout the year without even knowing it.

Research experience

I have worked in Dr. Cooper's lab for three years. Since my first month at UK, Dr. Cooper has shown me work ethics, strong dedication, and involvement in the community. This time spent in the lab has resulted in 27 presentations and 8 publications. My mentor has the ability to expose and accentuate the best in all the students he encounters. As required of any UK Beckman Scholar, I work in the lab at least 10 hours per week during the year, and 20 hours per week during the summer. Those hours are, however, often extended to allow further testing and to perform demanding experiments.

Working in Dr. Cooper's lab has certain characteristics that differentiate it from other research lab experiences I have had. Contrary to a vast number of college professors, Dr. Cooper spends a large portion of his time following the advances of the projects done by undergraduates. It has been common for me to spend hours in his office discussing the best way to answer

a certain scientific problem, e.g., "How can I demonstrate whether the fly's central nervous system is involved in the response of the animal to a given substance?" The lab atmosphere is also very positive because every student (doctoral, masters, and undergraduates) is aware of each other's projects and makes time to help each other. Finally, being part of a lab as productive as Dr. Cooper's (11 peer-reviewed publications while I was a Beckman Scholar) has an extremely invigorating effect on the students who are already excited about research.

Extra Activities

The Beckman Scholarship has given me much more than the opportunity to perform and present my research. This award has allowed me to be recognized as an undergraduate leader in the area of research throughout the University. This status has encouraged me to use available resources to promote more undergraduate research. As such, I co-founded the Society for the Promotion of Undergraduate Research (SPUR). This organization now includes more than 150 undergraduate student researchers and others interested in research. As an organization, we discuss current research performed by our fellow students, we offer help to find mentors and to deal with common problems, and we try to encourage even more involvement of students in research.

Because SPUR was such a success, I decided to contact the administration about creating an event that would showcase the research performed by undergraduates at the University of Kentucky. The event would publish an abstract of each project, would be entirely run by students, and would be friendly to a general audience. As a Beckman Scholar, I caught the direct attention of Dr. Philipp Kraemer, the Associate Provost for Undergraduate Education, who approved the funding for the project. As a result, the "Showcase of Undergraduate Scholars" became the largest academic event for undergraduate research at the university, presenting the work of more than 120 students.

My outreach activities have not all been done at the University. Growing up in France, I remember having the chance to attend some of the best and most demanding schools for my primary education. I vividly remember our teachers bringing guest speakers from universities to discuss complex concepts with us. This memory was decisive in my choice to become involved with middle and high school education in Kentucky. Dr. Cooper is always involved in outreach and offered me the opportunity to participate in a class he offers to teachers as part of their continuing education programs. The class was run by the Fayette County Public School and partially

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funded by the NSF. It enables middle and high school teachers to be updated on the latest research and find novel ways of teaching using lab equipment. As part of the teaching staff, I helped teachers understand some of the biological models, and I also took the initiative to teach one day when Dr. Cooper had to be absent. My presentation, entitled 13 tests to explain biology through *Drosophila*, was so appreciated that I was asked to be a teaching assistant the next time they had the class.

Now that I know many of the science teachers in Fayette county, I have started going to middle schools and high schools. When I go to schools, I particularly enjoy assisting students on science fair projects, for which I often serve as judge at the local and the regional level. I also often visit schools as a guest speaker, discussing my research and research in general. Going to schools has allowed me to assess the practicality of our teaching, thus allowing me insight into what to improve.

Another project I have pursued outside the University has been *Impulse*. This peer-reviewed journal, completely directed and reviewed by undergraduates, has been a most rewarding experience. I have been a reviewer for the journal for the past two years, and being able to help other undergraduates from around the world in their research is fascinating.

Benefits From Beckman

I do not believe that half of the projects, I have been part of would have been possible without the Beckman Scholarship. Receiving this award has allowed me to be financially independent, thus not having to have part-time jobs during the year and full-time jobs in the summer. Further, my success as a Beckman Scholar has permitted me to inspire students of all ages to participate in research.

Future Plans

I am not graduating until 2007; therefore, I plan on continuing all my activities for another year. There will certainly be plenty of lab work involved, but also some teaching, because I am a teaching assistant for two classes. My research will be more diverse because I will be working in three different labs in three different departments. I will continue going to schools in the community. I have recently planned a trip to an elementary school. The Showcase of Scholars will certainly be an important event this year and everyone is projecting another large attendance. SPUR will have the crucial task of finding new young talent to replace those of us who founded it and are about to graduate. *Impulse* has passed this problem and will certainly become a more and more well known journal as years go by.

As far as my career goals, I am still uncertain. I have a strong passion for people and research, thus, academic medicine may fit my personality. On the other hand, my eagerness to have a large impact pushes me toward public health. In that field, I would like to influence policy makers concerning the importance they place on research, and on the necessity to be aware of the latest research when creating guidelines or laws. I am currently applying to MD/PhD and MD/MPH programs around the country including at the University of California, San Francisco and Johns Hopkins.

Current Research

The following is the introduction to the latest research article that Dr. Cooper and I are submitting:

The normal function of ion channels, such as Ca^{2+} channels, within a given tissue can range from being essential for cell survival to only slight disturbances in function, depending on the cell's requirements. A variety of pathological conditions exist in humans, due to altered ion channel function in various tissues (Flink et al., 2003). Many of the known diseases related to ion channel function are due to mutational effects (Flink et al., 2003). Some of these pathologies are not severe enough to be lethal in embryological development but allow survival to some period, albeit with a decreased quality of life. The use of genetic mutations in animal models allows one to investigate the broad actions of such mutations in various bodily systems over acute and chronic periods, depending on the severity of the mutation and the functional needs of the animal.

The cacophony gene (*cac*) in *Drosophila* codes for the $\alpha 1$ subunit of a voltage-gated calcium channel. The $\alpha 1$ subunit produces the pore of the voltage-gated ion channel. With the use of a transgene to express green fluorescent protein (GFP) with a *cac*-encoded $\alpha 1$ subunit it has been demonstrated that motor nerve terminals in *Drosophila* express Ca^{2+} channels (Kawasaki et al., 2004). A mutation in this segment, has also been characterized in a temperature sensitive line (*cacTS2*) in which, the Ca^{2+} appear to have reduced flux when the temperature is raised, due to a conformational alteration in the channel. Synaptic transmission is reduced at the neuromuscular junction (Xing et al., 2004). *CacTS2* adults exposed to 38°C for 3 minutes stop flying and walking, which implies that the alterations measured electro-physiologically in the skeletal muscles of larvae also apply to motor units in the skeletal muscles of adults (Kawasaki et al., 2004) and, possibly, depresses other sites of synaptic communication centrally.



In this research, we used the *cacTS2* strain to investigate the potential effects on vision and olfaction in adult *Drosophila*. In larval *Drosophila*, we further assess regulation of heart rate as well as direct action in the heart at restrictive temperatures to further delineate the properties of the *cacTS2* strain. Mutations that are temperature-sensitive provide a good avenue to study the mechanisms of how homeostasis of an organism is regulated over time. Whereas complete knockouts of gene function can sometimes be lethal, the temperature-sensitive mutational forms can be pulsed for various increments of time to assess acute and chronic effects.

Because our knowledge of physiological mechanism largely derives from experiments in the larva (Koh et al., 2000), it is relevant to look at learning behavior in larvae with an alteration in Ca^{2+} function at the synaptic level.

Clinical approaches are used to regulate calcium channel function as a means to control pathological conditions such as epilepsy and convulsions (Warner et al., 2005). The outcome of long-term treatments of calcium channel blockers for regulation of such diseases needs to be addressed in terms of potential consequences in which homeostatic synaptic mechanisms may be compromised. It is possible that by examining effects on the long-term reduction of calcium influx and by simply revealing the mechanism induced by calcium blocking in defined model systems we will gain insight for clinical application.

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I spent the first one and a half years of my undergraduate career here at UK switching majors and mastering what I like to call the art of "add/drop." (I was just as indecisive in finalizing a semester's course schedule.) In fact, I once changed majors three times in a span of two days. Finally, after meeting with professors in areas such as Chemistry, English, and Journalism, I decided that Biology was the major for me. I was especially interested in biomedical research and medicine.

Because I had taken only one collegiate science course, I apprehensively enrolled in organic chemistry and cell biology courses for the spring semester of my sophomore year. At the time, I felt that the semester was greatly important and that my performance in these science courses would indicate, and maybe even shape, my newly founded undergraduate career. However, my Honors 202 course tested me most, but in a different manner than I expected.

Dr. David Wilke taught that course, entitled "The Contemporary World," which required a reading of A.H. Maslow's *The Farther Reaches of Human Nature*. In that book, I discovered the possibility of a different kind of education, and my discovery began with a realization that the state of my education in the opinion of Maslow, at the time, "summarizes the evils of extrinsically oriented education." That is, the numbers, names, facts, and formulas that I had simply been learning and memorizing (and later usually forgetting) are, according to Maslow, "in a certain, very profound sense, expendable."

Although, as I have already mentioned, I was enrolled in the Honors Program (which definitely promotes the development and use of creativity in a cross-disciplinary setting), I had fallen into

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the minimalist undergraduate mindset. At the time, anything above or beyond the requirements of a course were, to me, superfluous. I didn't attend many lectures by visiting professors or guest speakers, and, most importantly, I wasn't involved enough. So, as you can probably imagine, Maslow's idea of a "humanistic education" struck me as completely foreign and challenging but stuck with me. I recognized his idea as rather utopian, but I bound myself to expanding my education and to obtaining as much of an "intrinsic education" as possible in the remaining two years of my undergraduate stay.

Such a goal led me to consider earning credit in BIO 395, Independent Research, and my advisor, Dr. Sheldon Steiner, suggested some biology faculty members who were taking undergraduates in their labs. I studied the professors' areas of research and decided to meet with Dr. Bruce O'Hara, whose specialty is sleep and circadian rhythms. I didn't make an appointment but just showed up at Dr. O'Hara's office (definitely a testament to Dr. O'Hara's availability to his students and his productively relaxed attitude so conducive to creativity in learning and research). After five minutes of speaking with Dr. O'Hara about his research, I was intimidated, felt under-qualified, and wanted to leave; after half an hour, I was absolutely convinced that I was going to do research in Dr. O'Hara's lab. After about eight months of research in his lab, Dr. O'Hara brought to my attention the Beckman Scholars Award for Undergraduate Research and encouraged me to submit an application. It was extensive and required, among other things, a detailed project proposal, three faculty recommendations, and a personal statement concerning my future academic and career plans.

At some point during my first meeting with Dr. O'Hara (probably while he talked excitedly about his latest findings, because his passion and love of knowledge of all kinds is contagious), I was reminded of an essential component of Maslow's education: "peak experiences."

I firmly believe that Dr. Arnold Beckman either was well-acquainted with Maslow's work (or at least similar work), or independently discovered the same truths (brilliant minds think alike). Peak experiences form the foundation of the Beckman Scholars Program, and I'm convinced that Dr. Beckman had them in mind when he and his wife Mabel decided to encourage scientific education both financially and ideologically. Dr. Beckman himself must have lived by and thrived on peak experiences, because he made numerous medical and otherwise scientific inventions. "The picture of the creative scientist

must change, and is giving way to an understanding of the creative scientist, and the creative scientist lives by peak experiences," writes Maslow. "He lives for moments of glory when a problem solves itself, when suddenly through a microscope he sees things in a very different way, the moments of revelation, of illumination, insight, understanding, ecstasy. These are vital for him." I am especially grateful for the assistance that the Beckman Foundation has given to me in my goal of a more intrinsically-oriented education.

My main research project focuses on an examination of "clock-genes" (genes underlying mammals' circadian rhythmicity) that we believe are also important for sleep homeostatic regulation. I'm currently looking at clock-gene mRNA levels in response to sleep deprivation of varying durations in different parts of the mouse brain outside the mammalian master circadian pacemaker, and further comparing these results in different mouse strains with different sleep parameters. We've found that the clock-genes *period1* and *period2* mRNA levels increase with increasing sleep deprivation in both the forebrain and cerebellum of three mouse strains. Such a positive correlation with sleep deprivation further confirms our hypothesis that period clock-gene expression is also related to sleep homeostatic regulation.

I've also been involved in a study regarding human reaction-time performance in relation to meditation, sleep, exercise, and caffeine. We've found that meditation enhances reaction-time performance (i.e., reduces reaction-time) in a Psychomotor Vigilance Task more than sleep, exercise, or caffeine. For this study, we are currently seeking publication in the journal *Sleep*. Following the Dalai Lama's inaugural lecture on the neuroscience of meditation at the 2005 Society for Neuroscience Conference, the media has taken an interest in our meditation study. Dr. O'Hara has recently and frequently been interviewed, and already our findings in the meditation study have been featured in *Time Magazine*, *USA Today*, *New Scientist*, and *Science Update*. I will be presenting both studies' findings at the Society for Neuroscience Conference in October of 2006, and I've already presented preliminary findings of my molecular project at the Kentucky Posters-at-the-Capitol program and at UK's Showcase of Undergraduate Scholars.

The overall goal of my research (and presumably any research in the sleep field) is to contribute to a greater understanding of why we sleep. Today, we still have a poor understanding of the mechanisms underlying a process consuming approximately one-third of our lives! The function(s) of sleep is/are unknown; thus, my area of research is chuck-full of peak experiences waiting to happen. But, above all, above the physiological and molecular pathways important for sleep that I've learned, and above the small contribution that I've made to the research community, I've had a lot of fun. This fall I'll be attending medical school at the University of Louisville, where I plan to continue laboratory research. My career goal is to become involved in the implementation of laboratory research in a patient setting.